

## **2.0.8 SITING REQUIREMENTS FOR METEOROLOGICAL EQUIPMENT**

### **2.0.8.1 INTRODUCTION**

These siting criteria address meteorological equipment used in conjunction with air quality monitoring instrumentation. Proper siting of meteorological equipment is critical to obtaining good meteorological data. The primary objective of equipment siting is to place the meteorological equipment in a location where it can precisely measure the atmospheric conditions of the area of concern. Since atmospheric conditions change depending on height and surroundings, certain criteria are used for meteorological equipment siting to allow for measurement comparison. It is recognized that these siting criteria are an ideal goal and that there will be sites selected that do not meet the criteria. In those cases, the operating agency should carefully describe the discrepancies of the site to quantify the degree that the meteorological data may be compromised.

### **2.0.8.2 SITE DOCUMENTATION**

Meteorological sensors should be sited with an understanding of the large scale geographic area, the sources being investigated and the potential use of the data. Figure 2.0.8.1 describes the relationship between topography, air flow, and site selection. Once a site is chosen, documentation should include:

1. Discussion of the area terrain and land use within two kilometers from the monitoring site. Special attention should be paid to topographical features such as mountains, valleys, rivers, etc. Also, include any local obstructions (trees, buildings, towers, power lines, walls, other equipment or samplers).
2. Copies of local street and topographical maps of site locations.
3. Photographs of the site taken from the roof of the shelter in eight compass directions. Site photographs should be taken showing existing ground cover.
4. Diagram of shelter, sampling probe, meteorological tower, meteorological equipment, external sampling equipment, and nearby obstructions (natural or man-made).

### 2.0.8.3 SITING ACCORDING TO SPATIAL SCALES

Ideally the location of meteorological equipment should also comply with the representative spatial scales for criteria pollutants specified in U.S. EPA Volume II, Section 2.0.1. These scales are provided below. Both the transport and diffusion of air pollutants are complicated by topographical features. Figure 2.0.8.1 summarizes topographical features, their effects on air flow, and influences on monitoring site selection. This indicates that land topography or flow obstructions in the scale of concern can bias the measurement of meteorological parameters.

1. Microscale - concentrations in air volume with dimensions ranging from a few meters to about 100 meters.
2. Middle scale - concentrations typical of areas up to several city blocks with dimensions ranging from approximately 100 meters to 0.5 kilometers.
3. Neighborhood scale - concentrations within an extended area of the city that has relatively uniform land use with dimensions ranging from 0.5 to 4.0 kilometers.
4. Urban scale - overall citywide concentrations with dimensions of about 4 to 50 kilometers; this scale usually requires more than one site of definition.
5. Regional scale - usually concentrations measured in rural areas of reasonably homogenous geography that extend from 10's to 100's of kilometers.
6. National and global scales - concentrations characterizing the Nation and/or the globe as a whole.

### 2.0.8.4 METEOROLOGICAL TOWER SITING CRITERIA

It is recommended that towers should be located on an open level ground. If necessary, the tower may be located on a building roof. Figure 2.0.8.2 provides a summary of siting criteria for meteorological sensors. This information was summarized from U.S. EPA Volume IV Quality Assurance Handbook for Meteorological Measurements, Section 4.0.4.

1. The 10-meter open grid tower is a typical choice for supporting the meteorological sensors. The tower height can vary based on the height of the source, points of impact, the use of the data, and any space limitations of the site. The tower can either be a tilt-over or free standing design.

There are two designs of tilt-over towers which allow ground access to the sensors. The tower can hinge at the: 1) base, or 2) at an elevated level at the tower (this height depends on the manufacturer). The tilt-over tower can be lowered by hand provided that the weight can be safely maneuvered. If the tilt-over tower is too heavy or the tower tilts at an elevated level, an electric winch can be used to lower the tower. The tilt-over tower may also be climbed to access the sensors provided that it has been properly guyed.

Free standing towers may also be used and often require climbing the tower to access the sensors. An instrument lift can be used to support the sensors on taller towers (15-30 meters). The lift allows the sensors to be lowered to ground level whenever maintenance or repairs are needed. The sensors are then raised back up to monitoring height after the repair action is completed.

In all cases, towers should be installed and guyed based on the manufacturer's engineering requirements. Figure 2.0.8.2 provides a summary of tower siting criteria.

2. Due to location restraints, such as city codes, federal aviation codes, available space, etc., retractable tower or telescoping mast designs are also used to support the meteorological sensors. However, if an option is available, the tower designs described in Part 1 are recommended, as both the retractable tower and the telescoping mast designs may not provide secure support for the sensors. These tower designs can allow the boom to twist or vibrate affecting the sensor's measurement of wind flow.

The retractable tower usually is the three-sided design, with sections that are retracted into one another when access to the sensors is needed. Even when the bottom section is supported by a wall, it is recommended that the top section be guyed. This will minimize the chance that the sensors will move or slip from appropriate alignment when the tower is fully extended.

The pneumatic telescoping mast design has a base diameter of approximately five inches and is made of aluminum. If the first or bottom section is supported on a wall, etc., guy wires are not needed. The TV mast design has an overall diameter of approximately 2 inches, can be telescoped up to 40 feet, and requires guy wires for support. If the bottom section is supported by a wall, and the telescoping mast is not fully extended (i.e., there is overlap of sections for stability), guy wires may not be required. In this case, the discretion of the mast installer needed to verify the stability of the mast.

In all cases, the location of the sensors on the tower and the topographical features should be documented (Figure 2.0.8.1). To aid in this documentation, Figure 2.0.8.1 describes the relationship between topography, air flow, and site selection.

#### 2.0.8.5 WIND SPEED AND WIND DIRECTION SITING CRITERIA

**NOTE:** Open terrain is defined as an area where the horizontal distance between the sensors and any obstruction is at least 10 times the height of that obstruction.

1. If wind flow data covering a broad area is required, the wind sensors should be positioned away from the influence of complex terrain (cliffs, steep slopes, ridges or valleys).
2. The wind sensors should be mounted on a boom above the top of the tower or project horizontally from the tower side. The boom should not rotate, twist, or sway. The sensors should be mounted on a boom two tower widths away from the tower side. The "maximum diameter or width" of the tower will vary depending on the type of the tower used. The sensors should be mounted on a boom one tower width away from the tower top. The boom should project in the true North - South direction.
3. When absolutely necessary, the wind sensors may be located on a building roof. Initially, the sensors should be positioned above the roof at 1.5 times the height of the building. It is recognized that this height is not always feasible. It is imperative that an accurate and thorough description of the building and the surrounding terrain be provided.

2.0.8.6      TEMPERATURE AND RELATIVE HUMIDITY SITING CRITERIA

1.      Sensors should be positioned over open, level ground having a diameter of nine meters. It is recommended that the area should be covered with grass or natural earth. The surface should not be concrete, asphalt, or free standing water to avoid artificial heating or cooling of the sampled air.

Refer to Figure 2.0.8.2 for a summary of temperature and relative humidity sensor siting criteria.

2.      Sensors should be positioned 1.25 to 2 meters above the ground. This height can vary based on application. If mounted on a tower, the sensors should be positioned on the boom one tower width away.
3.      Sensors should be positioned away from obstructions. The recommended distance between the sensors and any obstruction is at least four times the obstructions height. Sensors should also be at least 30 meters from any large paved areas, and not close to slopes, ridges, and valleys.
4.      The sensors should be located in an aspirated radiation shield to overcome the effects of solar radiation and wind. For sites with winds generally above 1.5 meter/second, a well-designed, naturally aspirated radiation shield can be used. A motor aspirated radiation shield can be used when a site can experience extended periods of winds below 1.5 meters/second or the data application specifies its use. Naturally aspirated radiation shields should be positioned on the side of the tower facing the prevailing wind direction. Motor aspirated shields only need to meet height and boom length requirements.
5.      Louvered sensor shelters should be oriented with the air intake facing north.
6.      If vertical temperature difference measurements are required, the placement height of each temperature sensor should be specified by the regulator agency. If a 10-meter tower is used, generally the sensors should be located at the 2 and 10 meters.

2.0.8.7      SOLAR RADIATION SITING CRITERIA

1.      No obstructions should be above the horizontal plane of the radiation sensing element of upward looking radiation sensors. If possible, the

location of the solar radiation sensor should be observed during different times of the day. This will document any obstructions which could shade the sensor face as the sun changes angle and elevation throughout the day. Refer to Figure 2.0.8.2 for a summary of solar radiation sensor siting criteria.

2. Light colored walls which can reflect sunlight into the sensing element and artificial radiation sources should not be near the radiation sensor.
3. The radiation sensor should be located on a flat roof. If such a site is not available, a rigid stand with a horizontal surface should be used to support the sensor. The location should provide easy access to the sensor face to allow cleaning and maintenance.
4. A site survey of the angular elevation above the plane of the radiometer surface should be made through 360 degrees. This should be done to determine if an obstruction could shadow the radiometer surface as the sun moves through the day.

#### 2.0.8.8 PRECIPITATION SITING CRITERIA

Refer to the siting criteria provided in Section 2.0.5.

1. Precipitation samplers (rain gauge and collector) should be mounted on level ground so that the orifices are horizontal. If greater than 20 percent of the precipitation is snow, the rain gauge should be sheltered from the wind by an alter wind shield.
2. Obstructions to the wind should not be closer than two to four times the obstruction height from the sampler.
3. The surface around the precipitation samplers should be natural vegetation. The surface should not be paved as this could cause splashing into the gauge.
4. Objects over one meter high which can deflect wind should be greater than five meters from the collector.
5. Gauges should be mounted at least 30 centimeters above the ground and above the usual snow level. Rain collectors should be 91.4cm above the ground.

Topographical Feature	Influence on Air Flow	Influence on Monitoring Site Selection
Slope/Valley	Downward air currents occur at night and on cold days. Upslope winds tend to occur on clear days when valley heating occurs. Slope winds and valley channeled winds with a tendency toward down-slope and down-valley winds. There is a tendency towards inversions.	Slopes and valleys are special sites for air monitors because pollutants are generally well dispersed. The concentration levels are not representative of other geographic areas. Possible placement of monitors to determine concentration levels in a population or industrial center in a valley.
Water	Sea or lake breezes inland or parallel to shoreline during the day or in cold weather. Land breezes tend to occur at night.	Monitors on shoreline generally useful for background readings or for obtaining pollution data on water traffic.
Hill	Sharp ridges cause turbulence. Airflow tends to go around obstructions during stable conditions, but over obstructions during unstable conditions.	Depends on the source orientation. Upwind source emissions generally mixed down the slope, and siting at the foot of hill is not generally advantageous. Downwind source emissions are generally downwashed near the source. Monitoring near a source is generally desirable if there are population centers adjacent or of monitoring protects workers.
Natural or Manmade Obstructions	Eddy effects are common.	Placement near obstructions are not generally representative in readings.

This table is from U.S. EPA Volume II Quality Assurance Handbook for Ambient Air Specific Methods, Section 2.0.1, page 11.

Figure 2.0.8.1  
Relationships of Topography, Air Flow and Monitoring Site Selection

## SUMMARY OF METEOROLOGICAL EQUIPMENT SITING CRITERIA

Parameter	Height Above Ground (meters)	Horizontal Distance to Obstructions	Other Spacing Criteria
Tower	10	10 times the obstruction height, over level ground	<ol style="list-style-type: none"> <li>1. An open grid tower is suggested. The tower can be free standing, hinged at the base or an elevated level, or retractable/telescoping. Manufacturer's engineering requirements should be followed for installation.</li> <li>2. The tower height can vary based on the height of the source, points of impact, the use of the data, and any limitations of the site.</li> </ol>
Parameter	Height Above Ground (meters)	Horizontal Distance to Obstructions	Other Spacing Criteria
Wind Speed Wind Direction	10	10 times the obstruction height	<ol style="list-style-type: none"> <li>1. The 10 meter tower height is standard. The optimum measurement height may vary according to data needs.</li> <li>2. If on a building roof, the recommended height is 1.5 times the building height. When this height is not possible, documentation is essential.</li> <li>3. The sensors should be on a boom two tower widths away from the tower side. One tower width above the tower top.</li> <li>4. Flow obstructions (man-made or natural) should be well documented.</li> </ol>

Information is from EPA Volume IV Quality Assurance Handbook for Meteorological Measurements, Section 4.0.4.

Figure 2.0.8.2  
Meteorological Equipment Siting Criteria Summary

## SUMMARY OF METEOROLOGICAL EQUIPMENT SITING CRITERIA

Parameter	Height Above Ground (meters)	Horizontal Distance to Obstructions	Other Spacing Criteria
Temperature Relative Humidity	1.25 to 2	4 times the obstruction height	<ol style="list-style-type: none"> <li>1. The sensor height can vary depending on the data use.</li> <li>2. The sensors should be over open level ground covered in grass or dirt 9 meters in diameter.</li> <li>3. The sensors should be at least 30 meters away from large paved areas, slopes, ridges, and valleys.</li> <li>4. Aspirated radiation shields will be used.</li> <li>5. The sensors should be on a boom one tower width away from the tower side.</li> <li>6. If delta T is measured, the sensor heights should be assigned by the regulatory agency.</li> </ol>
Parameter	Height Above Ground (meters)	Horizontal Distance to Obstructions	Other Spacing Criteria
Solar Radiation	Flat roof or rigid stand, which allows access to the sensor.	Obstructions should not cast a shadow on the sensor face.	<ol style="list-style-type: none"> <li>1. Light colored walls or artificial radiation sources should not be near the sensor face.</li> <li>2. A site survey of the angular elevation above the plane of the sensor face should be made through 360 degrees.</li> </ol>

Figure 2.0.8.2 (cont'd)  
Meteorological Equipment Siting Criteria Summary

SUMMARY OF METEOROLOGICAL EQUIPMENT SITING CRITERIA

Parameter	Height Above Ground (meters)	Horizontal Distance to Obstructions	Other Spacing Criteria
Rain Gauge	30 cm.	2 times the object height.	1. The gauge should be on a level surface.  2. No object should project over the gauge.

Figure 2.0.8.2 (cont'd)  
Meteorological Equipment Siting Criteria Summary